I A Science for all Americans P.61-62

**Heredity**

One long familiar observation is that offspring look very much like their parents but still show some variation: Offspring differ somewhat from their parents and from each other. Over many generations, these differences can accumulate, so organisms can be very different in appearance and behavior from their distant ancestors. For example, people have bred their domestic animals and plants to select desirable characteristics; the results are modern varieties of dogs, cats, cattle, fowl, fruits, and grains that are perceptibly different from their forbearers. Changes have also been observed in grains, for example that are extensive enough to produce new species. In fact, some branches of descendants of the same parent species are so different from others that they can no longer breed with one another.

Instructions for development are passed from parent to offspring in thousand of discrete genes, each of which is known to be a segment of a molecule of DNA. Offspring of asexual organisms (clones) inherit all of the parent’s genes. In sexual reproduction of plants and animals a specialized cell from a female fuses with a specialized cell from a male. Each of these sex cells contains an unpredictable half of the parent’s genetic information. When a particular male cell fuses with a particular female cell during fertilization, they form a cell with one complete set of paired genetic information, a combination of one half set from each parent. As the fertilized cell multiplies to form an embryo, and eventually a seed or mature individual, the combined sets are replicated in each new cell.

Sorting and combination of genes in sexual reproduction results in a great variety of gene combinations in the offspring of tow parents. There are millions of different possible combinations of genes in half apportioned into each separate sex cell, and there are also millions of combinations of each of those particular female and male sex cells.

However new mixes of genes are not the only source of variation in the characteristics of organisms. Although genetic instructions may be passed down virtually unchanged for many thousands of generations, occasionally some of this information in a cell’s DNA is altered. Deletions, insertions, or substitutions of DNA segments may occur spontaneously through random errors in copying, or may be induced by chemicals or radiation. If a mutated gene is in an organism’s sex cell, copies may be passed down to offspring, becoming part of all their cells and perhaps giving the offspring new or modified characteristics. Some of these changed characteristics may turn out to increase the ability of the organisms that have it to thrive and reproduce, some may reduce the ability, and some may have no appreciable effect.

I B Science Matters P. 224-242

**All life is based on the genetic code.**

Works of Gregor Mendel

DNA & RNA Messengers of the Code

Letters of the Code- Nucleotides represent the “letters” of the genetic code

* A Adenine
* C Cytosine
* G Guanine
* T Thymine

Meiosis – Reproduction with Sex

Meiosis occurs only in specialized cells in the reproductive system. Chromosomes replicate then pair themselves and drawn to the poles of the cell along the spindles, are then separated the result the chromosomes are grouped in 4 quadrants of the cell and each group has exactly half the number of chromosomes in an ordinary cell. Fertilization is the union of these germ cells ovum and sperm. Fertilization produces a single cell, the zygote with full complement of chromosomes from egg one from sperm.

Genetic Engineering

DNA discovered in 1953 since then an enormous increase in the ability to understand life at the molecular level. The ability to manipulate DNA molecules and produce fundamental changes in living systems. Recombinant DNA is the use of particular enzymes to make a staggered cut in the DNA molecule, leaving several bases free. Another strand of DNA is then bound to the cut DNA strand.

Gene Regulation and Differentiation

Every cell in the body (except for the sex cells) contains exactly the same DNA and therefore exactly the same genes. Not every cell performs the same function. It is unclear and being researched exactly how genes are turned on and off.

Only about 5% of DNA in the body is taken up by gene, the function of the rest which is intermingled with the genes in all chromosomes in unclear. How complex organisms develop from a single cell is associated with gene regulation. All the cells in the body arose from a single cell, but are now very different and could not be turned into another. Cell differentiation is one of the main concerns of embryology. It appears that DNA doesn’t code only for proteins and regulation but it also contains instructions that turn genes on and off depending on how cells are developing else ware in an organism. Biologists have just started to scratch the surface of this complex problem, and we will not have complete understanding of molecular genetics until gene regulation and cell differentiation are understood.

DNA Fingerprinting

Electrophoresis

II A/III A Benchmarks for Scientific Literacy P. 108

DNA provides for both the continuity of trait from one generation to the next and the variation that in time can lead to differences within a species and to entirely new species. Understanding DNA makes possible an explanation of such phenomena as the similarities and differences between parents and offspring, hereditary diseases, and the evolution of new species, The understanding also makes it possible for scientists to manipulate genes and thereby create new combinations of traits and new varieties of organisms.

By the end of 12th grade, students should know that

* Some new gene combinations make little difference, some can produce organisms with new and perhaps enhanced capabilities, and some can be deleterious.
* The sorting and recombination of genes in sexual reproduction results in great variety of possible gene combinations from the offspring of any two parents
* The information passed from parent to offspring is coded in DNA molecules.
* Genes are segments of DNA molecules. Inserting, deleting, or substituting DNA segments can alter genes. An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little effect on the offspring’s success in its environment.
* Gene mutations can be caused by such things as radiation and chemicals.. When they occur in the sex cells, the mutations can be passed on to offspring; if they occur in other cells they can be passed on descendant cells only. The experiences an organism has during its lifetime can affect its offspring only if the genes in its own sex cells are changed by that experience.
* The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. Different parts of the instructions are used in different types of cells, influenced by the cell’s environment and past history.

II B / III B National science Education Standards P. 185

In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds ( A G C T ). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular letters) and replicated (by templating mechanism). Each DNA molecule in a cell forms a single chromosome.

Most of the cells in a human contain tow copies of each 22 different chromosomes. In addition there is a pair of chromosomes that determines sex; females contain two X chromosomes and males contain one X and one Y chromosome. Transmission of genetic information to offspring occurs through egg and sperm cells that contain only one representative from each chromosome pair. An egg and sperm unite to form a new individual. The fact that the human body is formed from cells that contain two copies of each gene- explains many features of human heredity, such as how variations that are hidden in one generation can be expressed in the next.

Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, others can change cells and organisms. Only mutations in germ cells can create variations that change an organisms offspring.

IV A Benchmarks for Scientific Literacy P. 341

Misconceptions:

1. Some students believe that traits are only inherited from one of their parents.
2. The traits are inherited from their mother because she gives birth or has the most contact as children grow up
3. The same sex parent will be the trait determiner
4. Students believe that certain characteristics are always inherited from the mother and others from the father.

Upper middle-school and High-School students should have the understanding that characteristics are determined by particular genetic entity which carries information translatable by the cell. Students of all areas believe that some environmentally produced characteristics can be inherited, especially over several generations.

IV B Making Sense of Secondary Science P. 51-53

**The Mechanism of Inheritance**

**Kargbo**

Half of children 7-13 give naturalistic explanations of the mechanism of inheritance: Nature makes offspring resemble parents. Some referred to environmental factors, some to somatic factors such as the brain or blood, only 4 subjects (amongst older children) implied any genetic principle. Pupils were not given insignificant, unconsidered answers, but they had established frameworks to make sense of the observations of inheritance.

Several Researchers have found that pupils, even before specific teaching, know of the word “gene” and less frequently “chromosome”. However pupils appear to understand little of the nature or function of genes and chromosomes, not appreciating that there is a chemical basis of inheritance.

**Lucas**

Adults understanding of scientific concepts found that half of the respondents volunteered that genes are responsible for the similarities between parents and offspring, but one-third could not offer any explanation of the phenomenon. People who had studied science had ho more knowledge of this topic than other people of the same educational level. ½ of Lucas’s sample chose a correct explanation of the mechanism of sex determination, compared to ¼ incorrect and ¼ “don’t knows”. A science education background made no difference to responses but gender did, with more women than men choosing correctly.

**Sources of Variation**

Lack of a precise concept distinguishing sexual reproduction form asexual reproduction appears to preclude an understanding of the origins of variation.

Several studies point to a very persistent alternative conceptions about the source of variation. Students invariably attribute observable variation to environmental factors alone. Sexual reproduction is not recognized as the source of variation in a population.

**Adaptation**

Most pupils appear to regard adaptation in terms of individuals changing in major ways to respond to their environment in order to survive.

Students appear to show confusion between an individual’s adaptation during its lifetime and inherited changes in a population over time. They tend to believe the Lamarckian theory of inheritance of acquired characteristics that individuals can adapt to change in environment if they need to and that these adaptations are inherited.

**Chance in Inheritance**

Pupils have some idea of the randomness of inheritance – that some times offspring are like their mother, sometimes like their father, sometimes both. **Kargbo**

Pupils rarely showed evidence of applying the concept of chance and probability to inheritance and evolution. The concepts of randomness and probability and not held by many students even after advanced courses. Many students could predict mathematical probabilities in isolated theoretical examples but could not do this with examples of situations in human families. **Hickman**